CLAIMS

1. A method for characterizing a contaminant in a fluid flow system, comprising the steps of:

(a) injecting a conservative tracer and an interactive tracer into the flow system at a first location;

(b) advecting the tracers along the flow system;

(c) extracting the tracers at a second location in the flow system;

(d) measuring the concentration of the extracted tracers over a period of time; and

(e) characterizing the contaminant from the concentrations of the tracers.

2. The method of claim 1 where the concentration is measured as a function of time.

3. The method of claim 1 wherein the characterizing includes detecting the presence of a specific contaminant of interest in the fluid flow system.

4. The method of claim 1 wherein the characterizing includes locating a specific contaminant of interest in the fluid flow system.

5. The method of claim 1 wherein the characterizing includes quantifying the amount of a specific contaminant in the flow system.

6. The method of claim 1 wherein the tracers are advected by a fluid that does not interact with the tracers or the contaminant.

7. The method of claim 1 wherein the interactive tracer is a partitioning tracer.

8. The method of claim 1 wherein the interactive tracer is a reactive tracer.

9. The method of claim 1 wherein a plurality of interactive tracers are injected.

10. A method for detecting the presence of a contaminant in a fluid flow system, comprising the steps of:

(a) injecting a conservative tracer and an interactive tracer into the flow system at a first location;

(b) advecting the tracers along the flow system with a fluid that does not interact with the tracers;

(c) extracting the tracers at a second location in the flow system;

(d) measuring the concentration of the extracted tracers over a period of time; and

(e) detecting the presence of the contaminant from a comparison of the measured concentrations.

11. The method of claim 10 where said concentration is measured as a function of time.

12. The method of claim 10 wherein the interactive tracer is a partitioning tracer.

13. The method of claim 10 wherein the interactive tracer is a reactive tracer.

14. The method of claim 10 wherein a plurality of interactive tracers are injected into the fluid flow system.

15. A method for determining the location of a contaminant in a fluid flow system, comprising the steps of:

(a) injecting a conservative tracer and a partitioning tracer into the flow system at a first location;

(b) advecting the tracers along the flow system at a first velocity to create an advection flow field;

(c) extracting the tracers at a second location in the flow system;

(d) introducing a perturbation to the advection flow field at a perturbation time by changing and then re-establishing the advection flow at a second velocity, which may be different than the first velocity, creating a unique change in the concentration of the partition tracer;

(e) extracting the partitioning tracer as a function of time relative to the perturbation time;

(f) measuring the concentration of the partitioning tracer as a function of the time; and

(g) determining the location of contamination from the time of arrival of the partitioning tracer relative to the perturbation time and the advection flow velocity.

16. A method for determining the quantity of a contaminant in a fluid flow system, comprising the steps of claim 1, wherein the quantity of extracted tracer is related to the quantity of contaminant.

17. An apparatus for characterizing a contaminant in a fluid flow system, comprising:

(a) a tracer injection system for injecting known amounts of conservative and interactive tracers into the flow system;

(b) an advection driving system for moving the tracers along the flow system;

(c) a tracer extraction system for removing the tracers from the fluid flow system;

(d) a measurement system for determining the concentration of the tracers extracted from the fluid flow system; and

(e) a processor for analyzing the concentration measurements.

18. The apparatus of claim 17, wherein the injection system includes a container with a valve holding tracers at pressure, whereby the tracers can be injected into the flow system by depressurizing the container by opening the valve on the container.

19. The apparatus of claim 17, wherein the driving system includes a compressed gas cylinder.

20. The apparatus of claim 17, wherein the measurement system includes a gas chromatograph.